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Small-scale vertical distribution of phytoplankton in Ezcurra Inlet (Admiralty Bay, South Shetland Islands)*)

ABSTRACT: Vertical distribution and quantitative and qualitative phytoplankton composition were studied in Ezcurra Inlet, Admiralty Bay, South Shetland Islands in the austral summer 1977/78. Nannoplankton flagellates, 12—15 μm in diameter and 4—6 μm "monads" were the principal algae of the plankton. Diatoms, present in a low abundance, were dominated by *Thalassiosira antarctica* and several species of the genera *Nitzschia* and *Chaetoceros*. Peaks of cell numbers within the 1—10 m surface stratum and at the bottom of the euphotic zone were characteristic of the vertical distribution of phytoplankton. Light, water movements and density micro-gradients were the likely factors controlling the vertical distribution of algae.

Key words: Antarctic, phytoplankton, small-scale vertical distribution

1. Introduction

Relatively much is known about the vertical distribution of phytoplankton in different regions of the Southern Ocean (Hardy and Gunther 1935, Hart 1942, Hasle 1969, Kozlova 1966, 1970, Zernova 1970, Steyaert 1974). No studies seem to have been reported however, of small-scale variations in the vertical distributions of Antarctic phytoplankton, although microstratifications of algae are commonly known to occur (Strickland 1968, Harris and Smith 1977). Elsewhere, small-scale vertical inhomogeneities in diatom distributions have been documented by Kray (1954) for summer populations in the North Sea and by McAlice (1970) for an estuarine species of *Asterionella japonica*. McAlice suggested that alterations in sea water density were responsible for the diatom variations within depth ranges of 10—50 cm in a New England estuary. According to Hasle (1950) phototactic responses in marine dinoflagellates caused vertical clumping within 2 to 5 m depth in Oslo fiord.

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Compared to diatoms very little is known about the abundance and distribution of the nannoplankton flagellates in Antarctic waters. Bunt (1960) observed unidentified green flagellates in large quantities of 240 cells$\cdot$ml^{-1} in the surface waters at Mawson and thought that they entered the water column from the sea ice. Hasle (1969) found that "monads and flagellates" dominated phytoplankton during the Brategg expedition at a station in the Bransfield Strait and a few other stations along Graham Land. Size fractionation experiments were conducted recently to determine the percentage contribution of nannoplankton to primary production in the Ross Sea (El-Sayed et al. 1978) and the Weddell Sea (El-Sayed and Taguchi 1977). In other oceanic areas studies made by Yentsch and Ryther (1959), Durbin, Krawiec and Smayda (1975), Watling et al. (1979) and others have shown the nannoplankton to be an important constituent of the microflora.

This paper reports a study designed to gain information about the small--scale vertical distribution, abundance and qualitative composition of the total phytoplankton in Ezcurra Inlet.

2. Materials and methods

2.1. Study site

The work was carried out in the central part of Ezcurra Inlet which is the south-western arm of Admiralty Bay, King George Island, South Shetland Islands (62°09′S, 58°28′W). The Inlet is 7 km long, 2—3 km wide, and has a surface area of ca. 17 km^2 (Rakusa-Suszczewski 1980). Its steep shores reach the elevation of 300—400 m, they are partly ice-free, but mostly are formed by glaciers covering King George Island. A 130 m high sill separates the bottom of Ezcurra Inlet from the main bay; another sill with depth rising to 150—80 m runs across the fiord and forms a division between two valleys: the eastern valley with glacial deposits at the bottom and depths rane between 150 and 270 m, and the western, shallower valley with depths of 50 to 80 m (Rakusa-Suszczewski 1980). The sampling station was situated above the central sill, east of Dufayel Island (Fig. 1).

2.2. Treatment of samples

Samples were taken every second day at noon time (GMT) during the period January 27 to February 18, 1978. On each date sixteen samples were collected; ten at 1-m intervals between surface and 10-m depth and the remaining ones at 5 or 10-m intervals untill the bottom was reached. Nansen-type bottles were used to obtain the samples. The 1-liter samples were immediately fixed with Lugol's solution and the remainder of the 5-liter water sample was used for nutrient and pigment analyses (Bojanowski, Hapter and Woźniak, unpublished data). In the ship's laboratory the phytoplankton samples were concentrated by settling to 100 ml and, prior to analysis, re-suspended and concentrated to 1 or 2 ml. A 0.05 ml pipete was used for

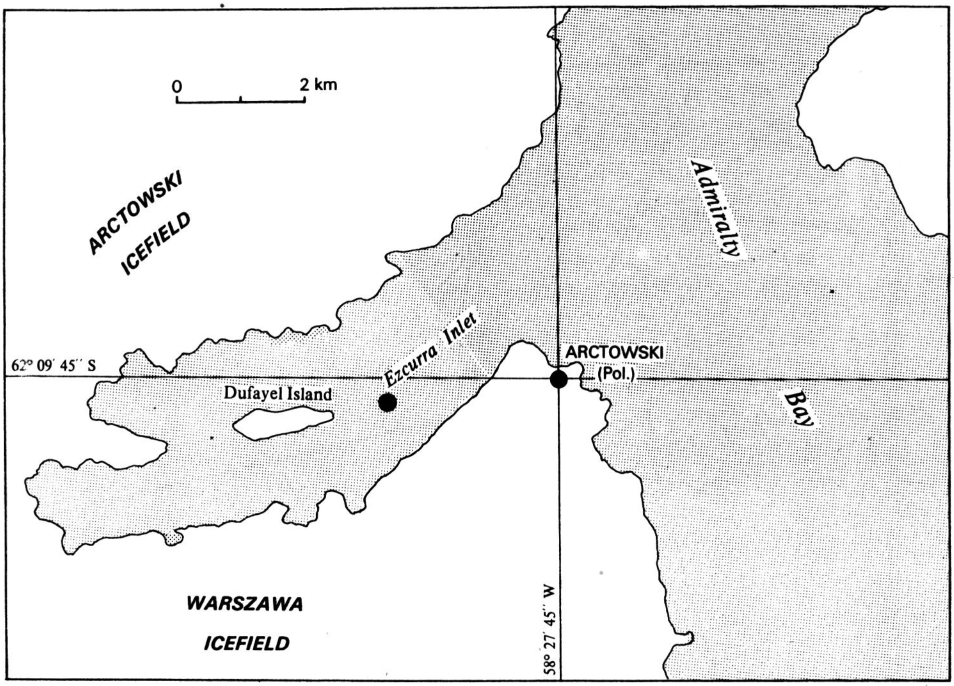


Fig. 1. The region of Ezcurra Inlet, Admiralty Bay (King George Island), showing the position of the sampling site

placing a drop of the concentrated material on a cover slide. Duplicate aliquots of the sample were examined with a Biolar PJ microscope under 400 × magnification and the algae counted in every second transect made across the slide. Diatoms were identified at 1500 × on material cleaned of organic matter according to the method of Fryxell (unpublished data[1]) and mounted in Coumarone or Turtox.

Net collections (mesh size 25 μm) were also made by vertical hauls at the same station and used for qualitative analysis.

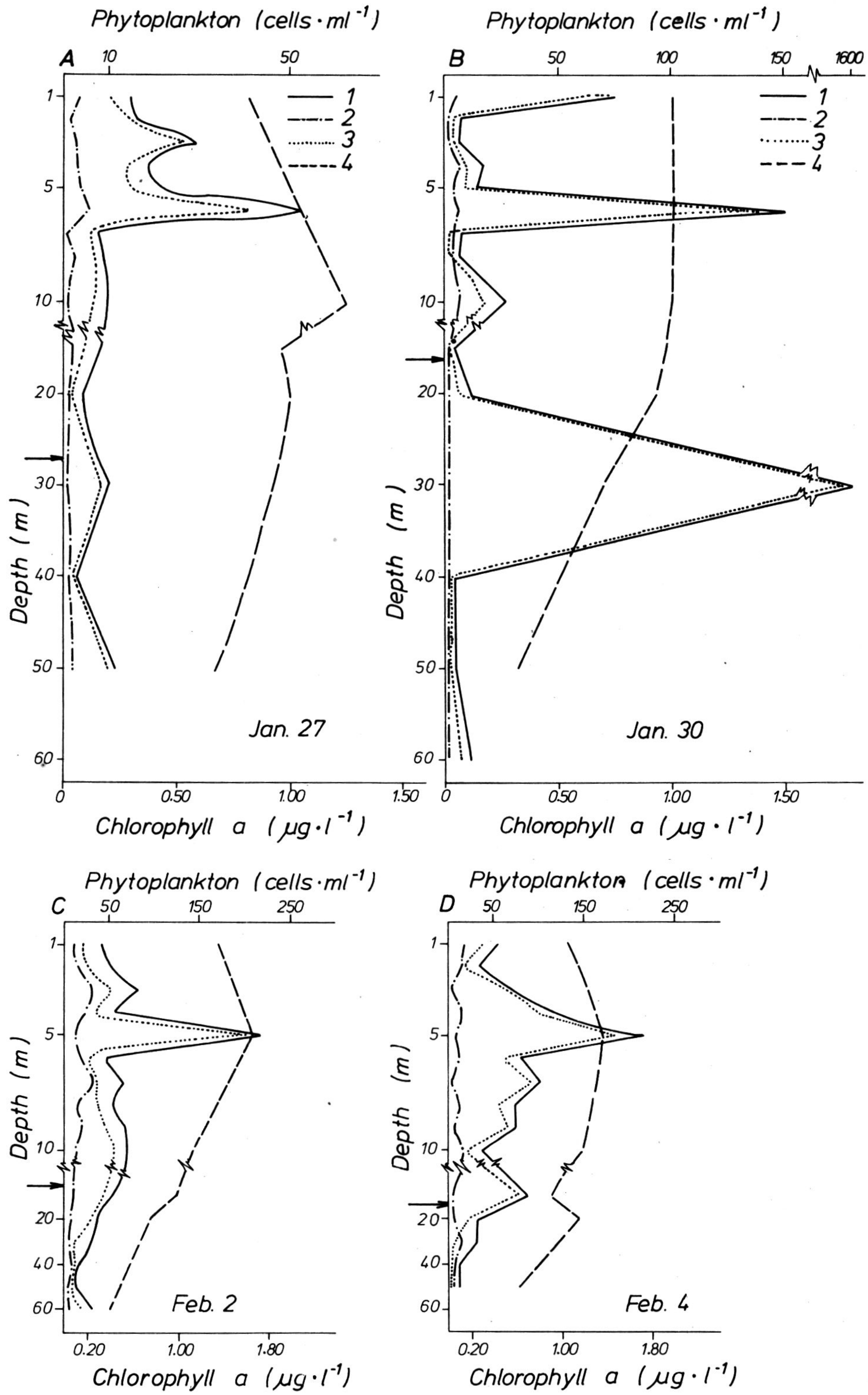
Compared with diatoms, the identification of other algae, particularly the naked flagellates presented much difficulties. After using the fixative, these organisms were found in a mutilated condition and satisfactory identifications, even to the genetic level, could not be made.

3. Results

3.1. Total counts

Figures 2A through 2J show the vertical distribution of cell counts of total phytoplankton and of two major algal groups, flagellates and diatoms.

[1]) Ph. D. dissertation: Morphology, taxonomy and distribution of selected diatom species of *Thalassiosira* Cleve in the Gulf of Mexico and Antarctic waters. Texas A and M University, College Station, Texas, 1975.



Phytoplankton (cells · ml⁻¹)
A
10
50
1
2
3
4
Jan. 27
Depth (m)
Chlorophyll a (µg · l⁻¹)
0
0.50
1.00
1.50
Phytoplankton (cells · ml⁻¹)
B
50
100
150
1600
Jan. 30
Phytoplankton (cells · ml⁻¹)
C
50
150
250
Feb. 2
0.20
1.00
1.80
Phytoplankton (cells · ml⁻¹)
D
50
150
250
Feb. 4

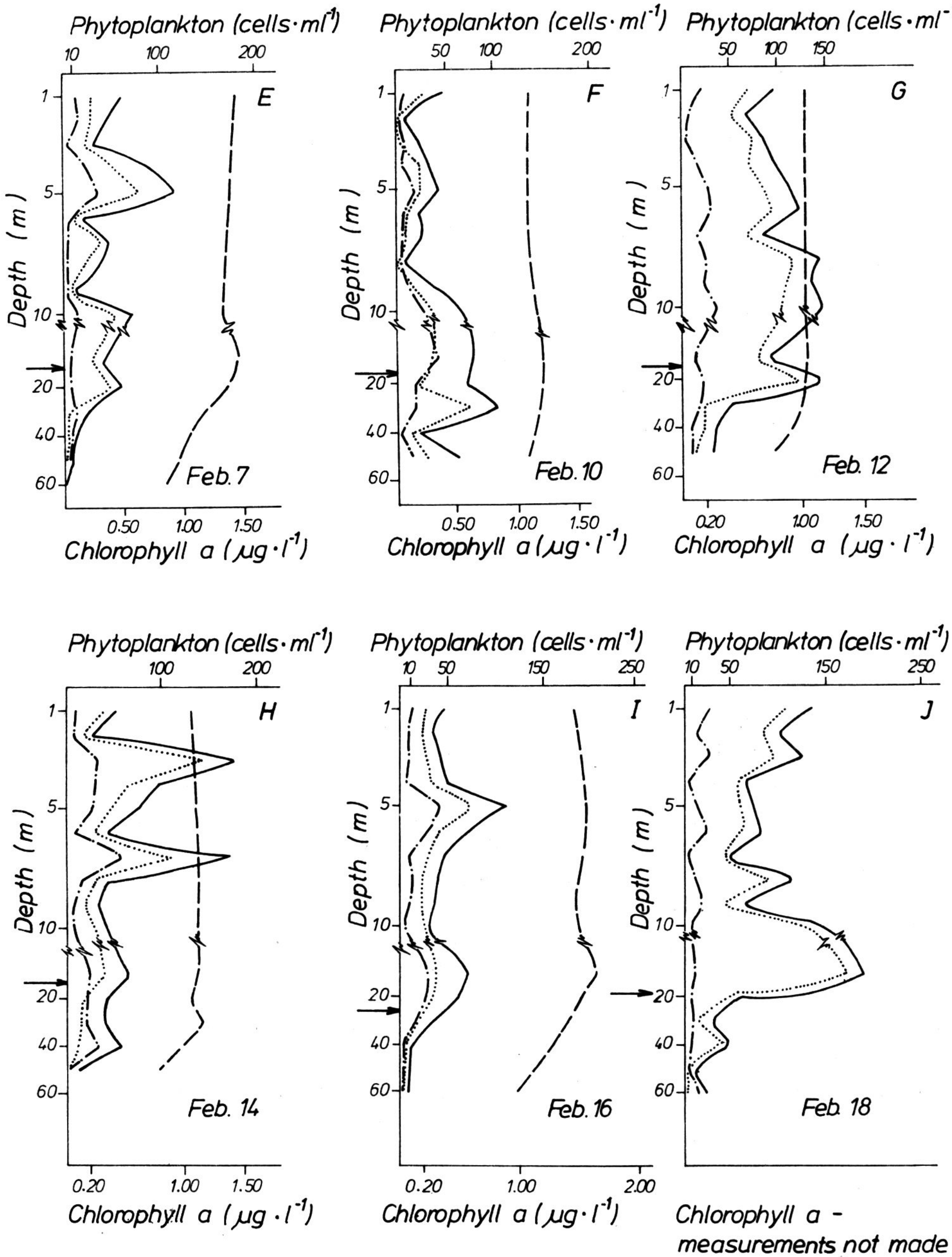


Fig. 2. Vertical distributions of total algae (1), diatoms (2), flagellates and monads (3), and chlorophyll *a* (4)

Arrows indicate depth of the euphotic zone. Chlorophyll *a* values are from Hapter and Woźniak, unpublished data. Figures A to J show the results for all sampling days between January 27th and February 18th, 1978.

Total cell numbers ranged between 2.6 cells·ml^{-1} at 40 m on January 27 and 217 cells·ml^{-1} at 5 m on February 2 and 4. An isolated peak of 1600 cells·ml^{-1} was found at the depth of 30 m on January 30. During the first two days of sampling (January 27—30) the total numbers were usually less than 20 cells·ml^{-1}. A marked, about five fold increase in the concentrations of cells was noted at most depths from January 27 till February 4. This change was mainly due to the occurrance of small flagellates and "monads". More or less similar total cell quantities (more than 40 or 50 cells·ml^{-1}) to those found on the latter date were noted in most cases during the subsequent sampling days until February 18.

The vertical distribution of phytoplankton was characterized by small peaks of numbers, usually greater than 100 cells·ml^{-1}, which were almost invariably present within the 10-m surface stratum, mainly at 5 and 6 m depths. Secondary equally small peaks in deeper water (15—30 m), often below the depth of euphotic zone, occurred on several ocasions (Figs. 2B, 2F, 2G, 2I, 2J).

3.2. Phytoplankton composition

Flagellates and "monads"

Differences in the total phytoplankton concentrations both spatial and temporal were mainly caused by small flagellates without a rigid wall and tiny "monads" which comprised together at least 50% and as much as 98% of the total numbers. The taxonomy of these nannoplankton organisms poses a serious problem and no specific identifications were attempted on the preserved material. A few observations made on fresh material led to the conclusion that most of the fragile naked flagellates could probably find their true affinities among the *Chlorophyceae* and *Chrysophyceae*. In the counts they were divided into two size groups: larger, ca. 12—15 μm in diameter, tentatively called *Chlamydomonas* spp., and smaller "monads", 4—6 μm in diameter. The organisms of the latter group were present usually in about twice higher abundance than *Chlamydomonas*. Vertical distribution of both groups combined together is illustrated in Figs. 2A through 2J.

Bacillariophyta

Diatoms comprised in most samples 10 to 40 percent of the total cell numbers. Smallest counts were found on January 27th and 30th when the numbers at all depths ranged between 0.5 and 7.4 cells in 1 ml. Maximal concentrations observed on each of the remaining sampling dates ranged between 17 cells·ml^{-1} (at 1 m on February 4th) and 57 cells·ml^{-1} (at 7 m, February 14th). Although quantities of diatoms were small the flora was very diverse; about 70 species were identified in this study (Kopczyńska, in prep.). An account of only the dominant genera and species will be given here.

Thalassiosira Cleve.

Thalassiosira antarctica Comber was the most numerous representative of the genus. This species together with other members of the genus, such as *T. delicatula* Hustedt, *T. gracilis* (Karst.) Hustedt, *T. perpusilla* Kozlova, *T. polychorda* (Gran.) Pr. Lavr., and *T. ritscheri* (Hust.) Hasle, which were present in much smaller quantities, comprised 40 to 90 percent of diatoms in all samples. The most frequently encountered cell size of *T. antarctica* was 17—20 μm. The cell sizes of the remaining species were usually within the 11—25 μm range. Some of the smaller *Coscinodiscus* cells might have been included in the counts made from water mounts. Vertical distribution of *Thalassiosira* spp. is shown in Fig. 3.

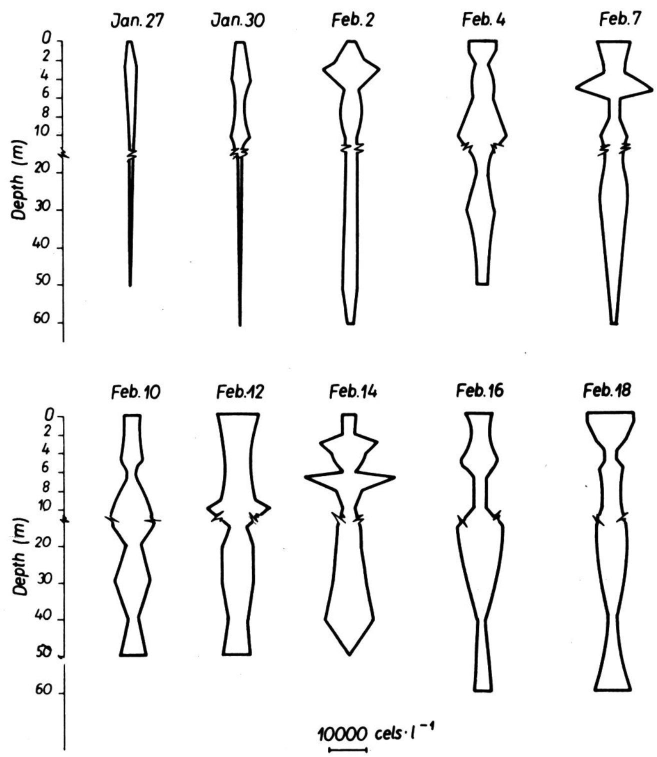


Fig. 3. Vertical distribution of *Thalassiosira* spp. during ten sampling days between January 27 and February 18, 1978

Nitzschia Hass., section *Fragilariopsis*.

Until recently members of this group were included in the genus *Fragilariopsis*. A close morphological relationship between the genera *Fragilariopsis* and *Nitzschia* was documented by Hasle (1965b, 1972) and the species of the former genus have been transferred (Hasle 1972) to the genus *Nitzschia*, section *Fragilariopsis*. All nine forms of *Fragilariopsis* characteristic of the Southern Ocean (Hasle 1965b) were present in higher or smaller quantities at all sampling depths. *Nitzschia kerguelensis* (O'Meara) Hasle, and at times *N. curta* (Van Heurck) Hasle or *N. cylindrus* (Grun.) Hasle assumed dominance or were co-dominant species of the group at various sampling dates. They were followed in order of decreasing abundance by *N. angulata* Hasle, (formerly *Fragilariopsis rhombica* O'Meara), *N. obliquecostata* (Van Heurck) Hasle, *N. sublineata* Hasle (formerly *Fragilariopsis sublinearis*), *N. lineata* Hasle (*Fragilariopsis linearis*), *N. ritscheri* (Hust.) Hasle, and *N. vanheurckii* (M. Per.) Hasle. All the species make *Fragilaria*-type, ribbon shaped chains and are easily confused when counded in girdle view in water mounts. This pertains especially to the small-size cells. Fig. 4 shows the vertical distribution of *Nitzschia* spp., section *Fragilariopsis*.

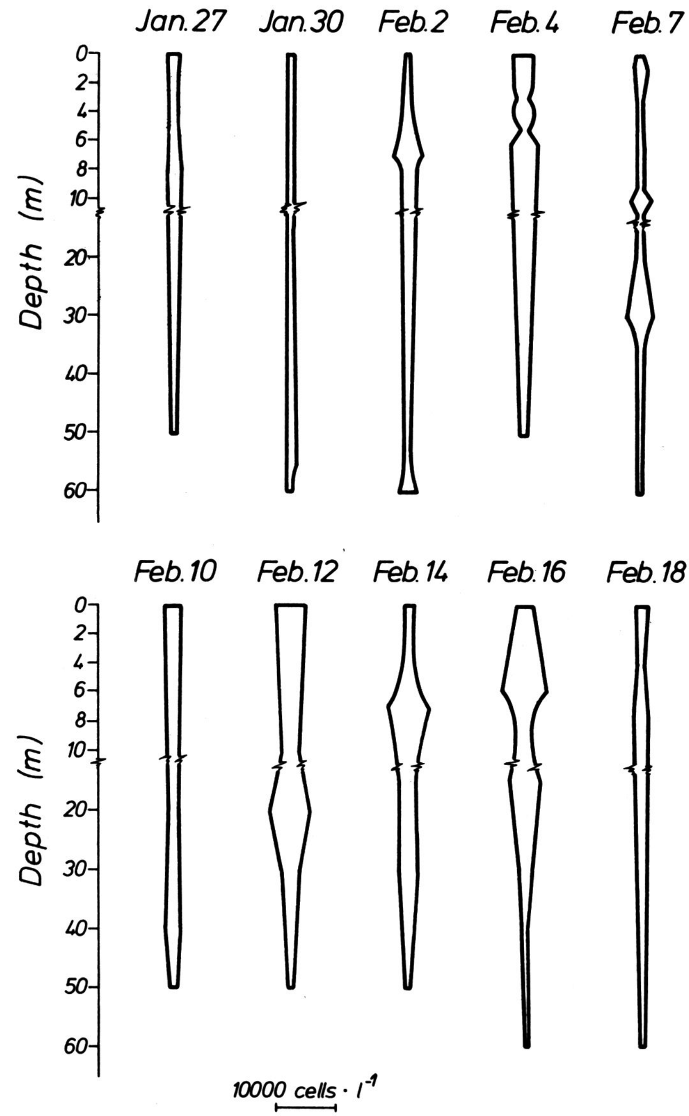


Fig. 4. Vertical distribution of *Nitzschia* spp., section *Fragilariopsis* during ten sampling days between January 27 and February 18, 1978

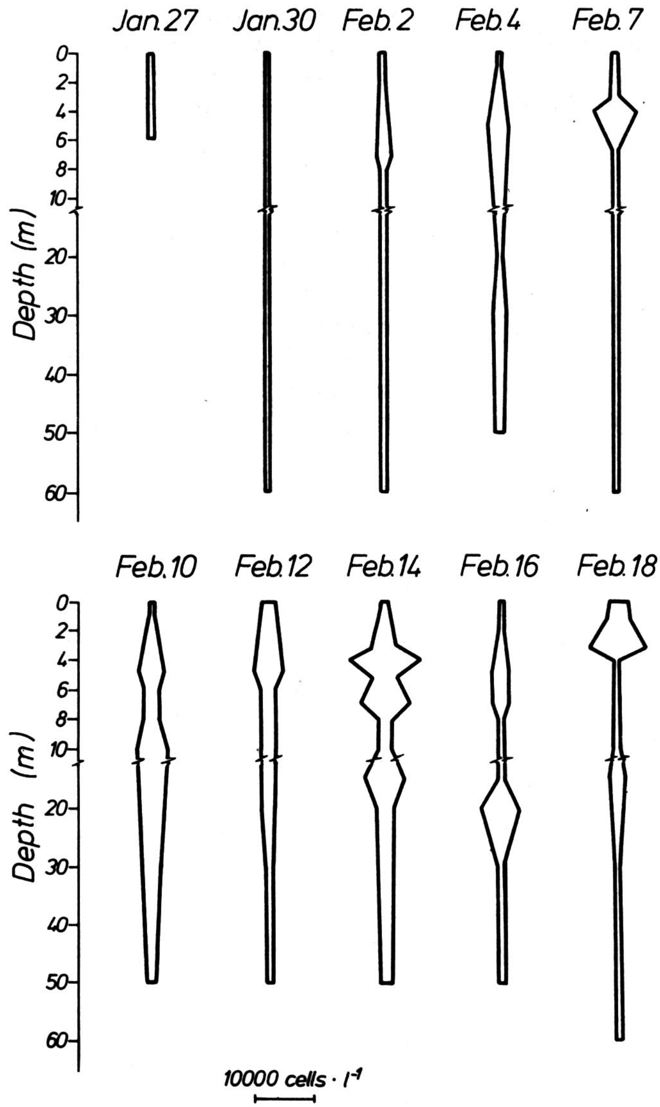


Fig. 5. Vertical distribution of *Nitzschia* spp., group *Pseudonitzschia* during ten sampling days between January 27 and February 18, 1978

Nitzschia Hass. group *Pseudonitzschia.*

Much confusion still exists in the taxonomy of this group. Most literature on Antarctic phytoplankton refer to *Nitzschia seriata* and *N. delicatissima.* It has been shown, however, that these two species do not occur in the Antarctic (Hustedt 1958, Hasle 1965a). Instead of, several other species of a similar morphology are present (Hasle 1965a). A few species, mainly of the *"Nitzschia delicatissima"* complex revised by Hasle were among principal diatoms in this study. *Nitzschia prolongatoides* Hasle was conspicuous in all samples often forming *Tabellaria*-like type of colonies. *Nitzschia lineo-*

la Cl., *N. heimii* Manguin and *N. turgidula* Hust. were also very common. *N. turgiduloides* Hasle was present in lowest abundance. In quantitative analysis based on water mounts the distinction between these species appearing in girdle view is scarcely recognizable. The combined counts of the group are shown in Fig. 5.

Chaetoceros Ehr.

In the period February 7th to 18th two species *C. neglectus* Karsten and *C. sociale* Lauder comprised a significant portion of the diatom assemblage in the upper stratum of the water column, mainly at 3 to 30 m. Much smaller quantities of these species were found in the earlier sampling period begining with Janv 27. Other members of the genus, such as *C. dichaeta* Ehr., *C. atlanticus* Cl., *C. criophilum* Castr., *C. tortissimum* Gran., and *C. chunii* Karsten were noted on most days, but in lower abundance. Fig. 6. illustrates the vertical distribution of *Chaetoceros* spp.

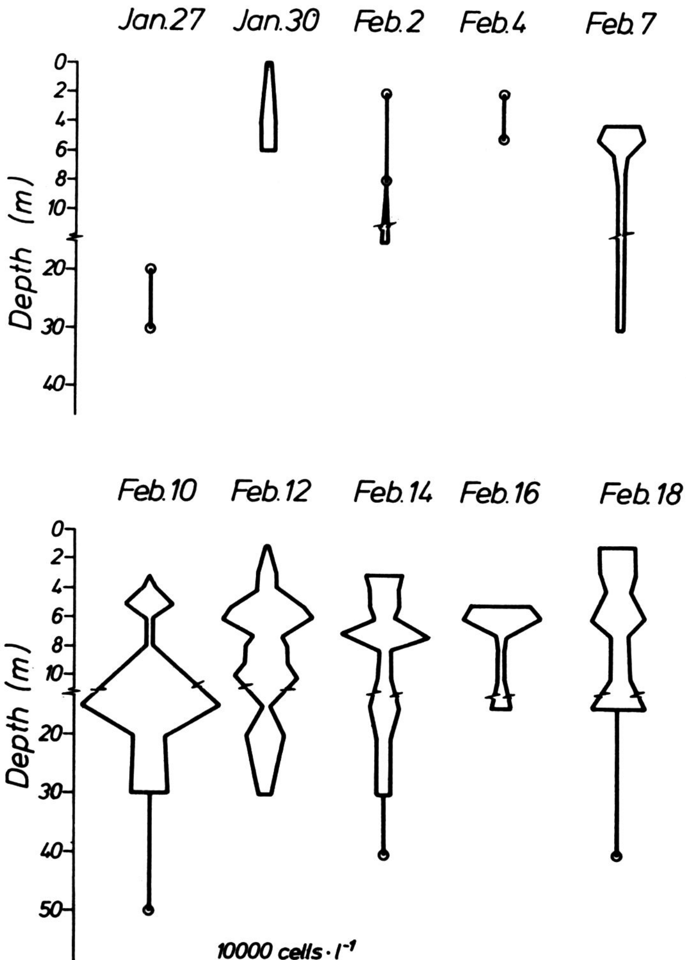


Fig. 6. Vertical distribution of *Chaetoceros* spp. during ten sampling days between January 27 and February 18, 1978

The genus *Coscinodiscus* Ehr. was represented by several species frequently occurring in the phytoplankton. Most characteristic were: *C. kryophilum* Grun., *C. bouvet* Karst., *C. tumidus* Janisch and *C. oculoides* Karst.

Among other diatoms, a few species, representatives of various genera, were rare (present in quantities less than 1 cell$\cdot$ml^{-1}) however, because of their large sizes, they were conspicuous in the whole-water bottle samples. To these belonged: *Corethron criophilum* Castr., *Biddulphia anthropomorpha* V. Heurck, *B. striata* Karst., *Eucampia balaustium* Castr., *Licmophora gracilis* (Ehr.) Grun., *Rhizosolenia alata* f. *inermis* (Castr.) Mangin, *R. alata* f. *gracillima* (Cl.) Grun., *R. hebetata* (Bailey) Gran., *R. truncata* Karst., *Synedra reinboldii* H. v H., *Thalassiothrix longissima* Cl. and Grun., and *T. antarctica* Cl. and Grun. In the net haul samples obtained between February 10 and 16, these diatoms, and first of all *Corethron criophilum* which exceeded other species many times in abundance, made up the bulk of the total phytoplankton.

Pyrrhophyta

Total cell densities of dinoflagellates ranged between 2 and 14 cells$\cdot$ml^{-1}. In majority of samples concentrations were less than 5 cells$\cdot$ml^{-1}. *Gonyaulax?* spp. was the dominant alga, followed by *Peridinium* spp. and *Dinophysis* spp.

Silicoflagellates

This group was represented by a single species *Dictyocha speculum* Lemm. rather frequently encountered in the samples.

4. Discussion

In an attempt to explain the phytoplankton results it is necessary to consider the physical and chemical data obtained during the Antarctic summer of 1977/78 in Ezcurra Inlet as well as the results of a more recent survey in 1978/79. According to the temperature and chemical measurements the waters at the station were most of the time well mixed and practically homogenous (Bojanowski and Lauer, unpublished data, Table I, herein). High turbidity values ranging between 2.8 and 183 mg$\cdot$l^{-1}, with an average of 44 mg$\cdot$l^{-1} in the near shore areas were recorded (Pęcherzewski 1980) for the whole Inlet and Admiralty Bay. Large amounts, up to 60 000 in 1 ml, of suspended particles in the water (Jonasz, unpublished data) caused that the depth of the euphotic zone in Ezcurra Inlet was shallow (see Fig. 2, A—J). Hydrographical studies (Pruszak 1980) showed that oceanic currents enter Admiralty Bay and Ezcurra Inlet at the bottom and make an exit at the surface. At times of prevailing westerly winds local upwellings occur in the region of the central sill in Ezcurra Inlet. Current velocities are usually high reaching 40 cm$\cdot$s^{-1}. A complete exchange of the whole

Table I

Physical and chemical data for the period January 27 to February 18, 1978, Ezcurra Inlet, Admiralty Bay

		27 Jan.	30 Jan.	7 Feb.	10 Feb.	14 Feb.	16 Feb.	18 Feb.
Water temperature (°C)*)	1 m	0.9	1.4	0.9	0.6	0.9	1.0	no data
	bottom	−0.2	0.5	0.5	0.4	0.6	0.5	
O_2 (ml·l^{-1})**)	1 m	7.68	7.64	7.62	7.42	7.50		7.59
	bottom	6.74	6.67	6.94	6.62	6.90	no data	6.60
	range	6.74—7.74	6.67—7.64	6.94—7.67	6.62—7.45	6.90—7.50		6.60—7.59
Si (μg at.·l^{-1})**)	1 m	80	81	80	82	80		81
	bottom	85	84	83	86	83	no data	84
	range	79—85	81—84	79—83	80—86	80—83		81—84
PO_4-P (μg at.·l^{-1})**)	1 m	1.71	1.58	1.96	2.06	1.97	2.14	2.01
	bottom	1.98	1.78	2.10	2.08	1.97	2.20	2.05
	range	1.71—1.98	1.58—1.78	1.85—2.10	1.97—2.08	1.89—1.97	2.08—2.20	2.00—2.05
NO_3-N (μg at.·l^{-1})**)	1 m	24	25	25	26	26	24	24
	bottom	28	28	28	29	27	25	26
	range	24—28	25—28	25—28	26—29	26—27	23—25	24—26
NO_2-N (μg at.·l^{-1})**)	1 m	0.18	0.16	0.16	0.17			
	bottom	0.14	0.16	0.16	0.16	no data	no data	no data
	range	0.14—0.18	0.16—0.17	0.15—0.17	0.16—0.17			
Depth of euphotic zone, 1% surface light intensity, (m)***)		26.9	16.0	16.6	18.5	16.9	30.1	19.3

*) Lauer, **) Bojanowski, ***) Olszewski, unpublished data

volume of water in Ezcurra Inlet with waters from the Bransfield Strait is possible within a fortnight.

The complex circulation of waters must create good conditions for vertical mixing and thus prevent the development of stratification in the water column for any longer periods of time. In the nearly homogenous waters at the station, total phytoplankton concentrations, both in terms of cell numbers and chlorophyll *a* showed considerable variations with depth (Figs. 2 and 7). It is characteristic that phytoplankton maxima occurred not only in the surface 1—10 m layer but also in the lower part of the euphotic

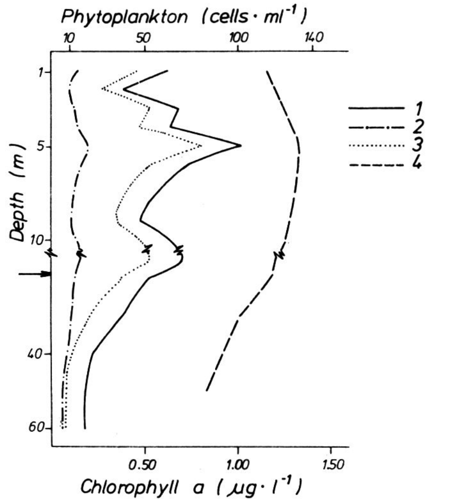


Fig. 7. Vertical distribution of average cell concentrations of total phytoplankton (1), diatoms (2), flagellates and monads (3) and chlorophyll *a* (4)
Averages are for ten sampling days in the period January 27 to February 18, 1978. Arrow shows the average depth of the euphotic zone for the same period.

zone (at 15—30 m) or even below it. Peak numbers were mainly caused by nannoplankton flagellates and monads. Large concentrations of these organisms close to the bottom of the euphotic zone (Fig. 2 B, D, F, G, J) suggest that at least some of them must be actively reproducing at very low light intensities. This corroborates the observations of Holm-Hansen et al. (1977) who stated that significant populations of Antarctic phytoplankton are active at light intensities corresponding to 0.1 and even 0.01 percent of the incident surface light. The occurrence of phytoplankton maxima at the lower part of the euphotic zone could probably be also explained by photoinhibition of cells in surface waters. As found by Holm-Hansen et al. (1977) during Eltanin cruises in the Southern Ocean, when incident light intensities were high, photosynthetic rates were low in the incident waters and they increased with depth. Phytoplankton standing crop maxima at the bottom or below the euphotic zone have been previously reported from the Antarctic during the Eltanin cruises in the South Pacific (El--Sayed 1978).

Similarly to the total phytoplankton and flagellates also the dominant diatom genera (Figs. 3 to 6) showed much variation in their vertical distribution. When average quantities of the individual genera for the whole sampling period were plotted (Fig. 8) considerably more uniform distribution of cells within the water column was shown, with an apparent "preference" for the upper 1—20 m stratum. Most interesting is perhaps the distribution pattern of *Chaetoceros* spp. (Fig. 6 and 8); the species were practically

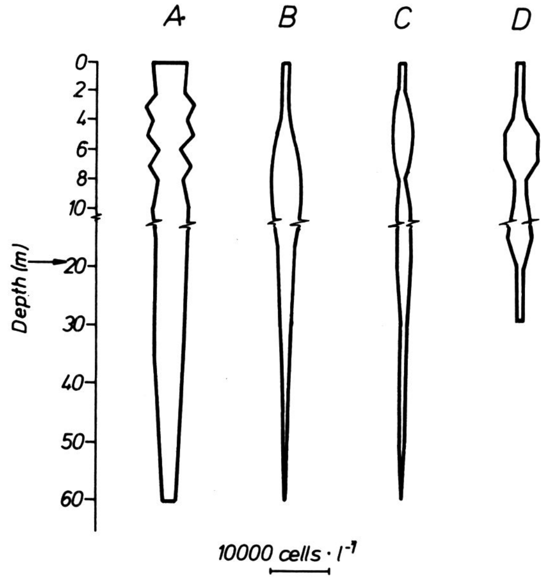


Fig. 8. Vertical distribution of average counts of *Thalassiosira* spp. (A), *Nitzschia* spp., section *Fragilariopsis* (B), *Nitzschia* spp., group *Pseudonitzschia* (C), *Chaetoceros* spp. (D) Averages are for ten sampling days in the period January 27 to February 18, 1978. Arrow shows the average depth of the euphotic zone.

absent below 30 m. It might be that *Chaetoceros* is more successful than other diatoms in maintaining itself in the optimal light zone. This might be due to a number of reasons. The populations of the two major species of *Chaetoceros, C. sociale* and *C. neglectus* apearred to be physiologically young and actively growing at the time of sampling since a singificant increase in their numbers was noted in the middle of the study period. In addition to that, the colonies of *C. sociale* were embedded in gelatinous masses; such gelatinous secretions of cells have been traditionally viewed as a flotation adaptation (Smayda 1970). In fact, it appears that gelatinous sheaths might be of special importance for diatoms suspension in colder waters, since according to Hendey (1937), the production of mucilage by *Chaetoceros* increases as the species proceed southward. Another successful suspension adaptation of *Chaetoceros* species seems to be their long fine setae which may increase the frictional drag of the cells and thus decrease their sinking rates and which may also help to orient the cells into the "preferred position" within the water column (Smayda 1970). The present observations suggest, in fact, that the setose-type chain of *Chaetoceros* might be superior to be morphological forms of the other diatoms present (ribbon--shaped colonies of *Fragilariopsis*, cylindric cells of Pseudonitzschia united by overlapping apices, discoid cells of *Thalassiosira* joined by mucous treads) in the ability to successfuly remain in suspension. The extent of this ability however, probably much depends on the physiological condition of the cells.

Physical factors, such as density gradients, water movements and light had very likely also a significant effect on the vertical distribution of diatoms and other phytoplankters. In spite of the general picture of well mixed waters in Ezcurra Inlet, the combined action of intense solar radiation, ice melting and fresh water runoff must have created good conditions for the development of low density microlayers at the surface which may have helped in the suspension of species of equivalent densities. Hendey (1937) noted that *Chaetoceros neglectus* — one of the major diatoms in this study — was associated with waters of lowered salinities. Such small-scale density layers coupled with wind stress, may also lead to vertical density currents, which together with turbulence and other water movements on a larger scale, such as the ascending currents typical for Ezcurra Inlet (Rakusa-Suszczewski 1980) will most likely affect the vertical distribution of phytoplankton through the sorting out and moving of cells according to their densities and sinking rates (Smayda 1970). Light could influence phytoplankton distribution both by photoinhibition of cells in surface waters (Holm-Hansen et al. 1977) and perhaps also by inducing phototactic movements in the flagellates and diatoms, although little is known about such posibility for the latter group (see Halldal 1962, Smayda 1970). It appears that the changeable from day to day vertical distribution patterns of major diatoms (Figs. 3 to 6) could probably be best explained by the combined effect of water movements and light.

All of the principal diatoms reported here are common and often abundant constituents of the plankton in various other localities of the Atlantic, Pacific and Indian Ocean sectors of the Antarctic. This is not surprising since a circumpolar distribution of Antarctic diatoms has been generally assumed. But the most interesting aspect of the diatom assemblage is that it contained forms obviously representing a variety of habitats. Some species, such as *Nitzschia curta, N. obliquecostata, N. sublineata, N. ritscheri* or *N. vanheurckii* are reported in the literature to occur in highest abundance near the Antarctic coast, or they have been termed as ice forms (*N. sublineata, N. cylindrus*). Others seem to be widely distributed in the open oceanic waters in the Antarctic and, or Subantarctic (*Chaetoceros neglectus, Nitzschia kerguelensis, N. prolongatoides, Rhizosolenia truncata*). Two major diatoms of the assemblage *Thalassiosira antarctica* and *N. cylindrus* are considered as bipolar in distribution and thus, as suggested by Smayda (1958), they probably must be able to thrive in the tropics as well, for a successful trans-tropical transport. Species such as *Chaetoceros sociale, C. tortissimum, N. lineola, R. alata* f. *gracillima* have been frequently observed in both northern and southern hemispheres, while many other species present in Ezcurra Inlet (*Synedra reinboldii, Thalassiotrix antarctica,* most of the *Fragilariopsis* forms) are endemic diatoms in the Antarctic waters.

All of the large-size diatoms (*Corethron criophilum, Eucampia balaustium, Biddulphia striata* etc.) have been previously reported as abundant in net samples obtained from the Bransfield Strait which is the locality nearest to the present sampling site where any previous phytoplankton investigations were carried on (Hart 1934, 1942, Hendey 1937, Macchiavello 1972).

In terms of numbers nannoplankton flagellates and "monads" were by far the most abundant algae of the plankton. The relative importance of this group would probably be reduced if standing crop were determined on the basis of cell volume or fresh weight rather than cell number. However, the obvious correlations of flagellates and monads with chlorophyll *a* (Fig. 2 A, C, D, F, G, J and Fig. 7) show the significant contribution of this group to the primary production. These organisms together with the small size (<20 µm) diatoms, especially of the genus *Thalassiosira* make probably an excellent diet for small *Calanoida* and small species of krill such as *Euphausia crystallorophias* Holt and Tattersal. At the time of the present study zooplankton populations were dominated by small *Calanoida* (<1 mm) e.g. *Drepanopsis pectinatus* Brady and *Scolecithricella glacialis* Giesbrecht (Węgleńska and Chojnacki, unpublished data), while krill swarms in Ezcurra Inlet contain except for *Euphausia superba* Dana, also smaller species i.e. *E. crystallophias,* and *Thysanoessa macrura* G. O. Sars (Kittel, 1980, Rakusa-Suszczewski, and Stępnik, 1980). The former species forms probably a local population in Ezcurra Inlet (Rakusa-Suszczewski and Stępnik, 1980).

Numbers of total phytoplankton (2—217 cells·ml^{-1}) and especially of diatoms (0.5—57 cells·ml^{-1}) were rather small, of the order of those found by Kozlova (1970) in the open oceanic waters of the Indian and Pacific sectors of the Southern Ocean, between the Antarctic Convergence and Divergence. Much greater quantities of diatoms reaching 1000 cells·ml^{-1} can be observed in the coastal areas of the Antarctic, south of the Antarctic Divergence (Kozlova 1970). The question is what are the significant environmental factors governing the phytoplankton abundances in the waters of Ezcurra Inlet. Nutrient levels (Table I) were high and not likely to affect phytoplankton growth. When all is considered it appears that the high turbidity (average 44 mg·l^{-1}) which attenuates the amount of light in the water, and the complex circulation of currents which prevents stability of the water column, are the two likely important factors which will hinder any greater development of planktonic algae in the area of the present sampling site. As observed by Sverdrup (1953), Hasle (1956), El-Sayed, Mandelli and Sugimura (1964) and others, a certain amount of stability of the water column is necessary for high phytoplankton production, since when the mixed layer of the water is deep, algal cells are carried below the optimal light zone.

The final question is how representative are the quantitative and qualitative phytoplankton results obtained from a single station for the entire Ezcurra Inlet or the entire Admiralty Bay. Recent data on chlorophyll *a* distribution (Lipski, unpublished data), show an increase of the surface pigment values from the west end of Ezcurra Inlet toward the open waters of Admiralty Bay and further on towards Bransfield Strait; as stated by Rakusa-Suszczewski (1980) these differences in chlorophyll values are caused by upwellings in Ezcurra Inlet. "Patchy" horizontal distributions of phytoplankton, even on a small scale, appear to be the rule in the surface waters of the oceans (Platt, Dickie and Trites 1970, Harris and Smith 1977). It is likely, therefore, that sampling at many points in the Inlet and the Bay would reveal much variation in the cell concentrations and perhaps also in the qualitative composition of the phytoplankton. On the other hand, it must be remembered that the position of the present sampling station was changing each day with the movement of the anchored ship.

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5. Summary

Small-scale vertical distribution and quantitative and qualitative phytoplankton composition were studied at 16 sampling depths in the central area of Ezcurra Inlet, Admiralty Bay, (King George Island, South Shetland Islands), during ten days between January 27 and February 18, 1978. Except for an isolated peak of 1600 cells·ml^{-1}, the cell counts of total phytoplankton ranged between 2.5 and 217 cells·ml^{-1}. Nannoplankton flagellates, 12—15 μm in diameter and 4—6 μm "monads" comprised the majority of the phytoplankton numbers in all samples. Significant contribution of this group to primary production was shown by correlations with chlorophyll *a*. Diatoms, although present in a low abundance (0.5—57 cells·ml^{-1}), were represented by 70 species. *Thalassiosira antarctica* and species of the genus *Nitzschia,* section *Fragilariopsis* and group *Pseudonitzschia,* and also representatives of the genus *Chaetoceros* were the principal diatoms. Vertical distribution of phytoplankton (Figs. 2 and 7) was characterized by small peaks of numbers (ca. 100 cells·ml^{-1}) within the upper 1—10 m stratum of the water column, mainly at 5 or 6 m; peaks at the lower level of the euphotic zone, at 15—30 m, occurred occasionally. Dominant genera of diatoms showed much variation in vertical distribution (Figs. 3 to 6) with an apparent preference for the upper 1—20 m stratum (Fig. 8). Species of *Chaetoceros* appeared to be more successful than other diatoms to remain in suspension; this might have been due to their morphological form and physiological condition. Light, water movements and density microgradients were likely to control the vertical distribution of phytoplankton. Instability of the water column and high turbidity were the two likely significant factors controlling the numerical abundances of phytoplankton in the study area.

6. Резюме

Количественный и качественный состав фитопланктона и его вертикальное размещенние в колонне воды исследовано на 16-ти глубинах в центральной части фиорда Эзкурра (Адмиральты Бей, Кинг Джордж Исланд, Южные Шетланды) в период от 27-го января до 18-го февраля 1978 г. Кроме одного случая находки большой концентрации клеток (1600·мл$^{-1}$) вся численность фитопланктона заключалась в пределах 2,5 до 217 клеток·мл$^{-1}$. Наннопланктоновые жгутиковые с диаметром 12—15 μм и „монады" 4—6 μм были преобладающими водорослями во всех испытаниях. Корреляции этой группы с хлорофиллом указывали на значительное участье наннопланктона

в первичной продукции. Численности диатомей были небольшие (0,5—57 клеток·мл⁻¹). Флору представляло только 70 видов. Среди них преобладали *Thalassiosira antarctica* и рода *Chaetoceros*. Характерной чертой вертикального размещения фитопланктона как целого (рис. 2 и 7) было выступление максимального сгущения клеток (ок. 100·мл⁻¹) в верхнем слое воды (1—10 м) в основном на глубине 5-ти или 6-ти метров; в нескольких случаях замечено максима у нижнего предела эуфотичной зоны на 15—30 м. Доминирующие диатомеи указывали на большую дифференциацию в вертикальном размещении в колонне воды (рис. 3 до 6) с выразительной тенденцей заселения верхнего (1—20 м) слоя (рис. 8). Итоги исследований указывали, что виды рода *Chaetoceros* вероятно благодаря морфологической форме и физиологической форме были более приспособлены удерживаться в оптимальной зоне света, чем другие диатомеи. Свет, водные течения и микродиапазовые разницы в густоте воды были вероятно главными факторами контролирующими вертикальное размещение фитопланктона. Недостаток постоянности в колонне воды, а также большое количество взвеси являются вероятно главными факторами, которые контролируют численность фитопланктона в районе исследований.

7. Streszczenie

Ilościowy i jakościowy skład fitoplanktonu i jego pionowe romieszczenie w kolumnie wody badano na 16-tu głębokościach w środkowej części fiordu Ezcurra (Zatoka Admiralicji, Wyspa Króla Jerzego, Południowe Szetlandy), w okresie od 27-go stycznia do 18-go lutego 1978 r. Oprócz jednego przypadku znalezienia dużej koncentracji komórek (1600·ml^{-1}), całkowita liczebność fitoplanktonu zawarta była w granicach 2,5 do 217 komórek·ml^{-1}. Nannoplanktonowe wiciowce o średnicy 12—15 µm i "monady" 4—6 µm, stanowiły przeważającą część glonów we wszystkich próbach. Korelacje tej grupy z chlorofilem *a* wskazywały na znaczny udział nannoplanktonu w produkcji pierwotnej. Liczebności okrzemek były małe (0,5—57 komórek·ml^{-1}), ale flora była reprezentowana przez 70 gatunków. Wśród nich dominowały *Thalassiosira antarctica* i gatunki rodzaju *Nitzschia*, grup *Fragilariopsis* i *Pseudonitzschia* i rodzaju *Chaetoceros*. Charakterystyczną cechą pionowego rozmieszczenia fitoplanktonu jako całości (rys. 2 i 7) było występowanie maksymalnego zagęszczenia komórek (ok. 100·ml^{-1}) w górnej warstwie wody (1—10 m) głównie na głębokościach 5-ciu lub 6-ciu metrów; w kilku wypadkach zauważono maksima przy dolnej granicy strefy eufotycznej, na 15—30 m. Dominujące okrzemki wykazały duże zróżnicowanie w pionowym rozmieszczeniu w kolumnie wody (rys. 3 do 6) z wyrażaną tendencją do zasiedlenia górnej (1—20 m) warstwy (rys. 8). Wyniki badań wskazywały, że gatunki rodzaju *Chaetoceros*, prawdopodobnie dzięki formie mofrologicznej i kondycji fizjologicznej, były bardziej przystosowane niż inne okrzemki do utrzymywania się w optymalnej strefie światła. Światło, prądy wodne i mikroskalowe różnice w gęstości wody były prawdopodobnie głównymi czynnikami kontrolującymi pionowe rozmieszczenie fitoplanktonu. Brak stabilności w kolumnie wody, jak również duże ilości zawiesiny są najprawdopodobniej głównymi czynnikami, które kontrolują liczebność fitoplanktonu w obszarze prowadzonych badań.

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